



**NIGERIA ASSOCIATION OF GEODESY
(NAG)**

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Assembly**

**DIFFERENCE IN POSITIONS CALCULATED
USING DGPS/GNSS OBSERVATIONS IN
NIGERIA - COMPARING OLD AND NEW
TRANSFORMATION PARAMETERS**

BY

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❑ INTRODUCTION

❖ GNSS Applications

- o Navigation
- o Positioning
- o Timing

❖ Transformations used Nigeria

- o Office of the Surveyor-General of the Federation (OSGOF) - Seven Parameters (NEW).
- o KARIAALA Consulting of Port-Harcourt - Seven Parameters (OLD)
- o Shell Petroleum Developing Company (SPDC) - Seven Parameters (OLD)
- o Consolidated Oil Company (CONOIL) (OLD)
- o AGIP - Seven Parameters
- o CHEVRON - Three Parameters (OLD)
- o NORTEC - Seven Parameters
- o ELF - Three Parameters (OLD)
- o EXXON-MOBIL - Three Parameters (OLD)

❖ **Transformations Derived by DMA and other academic scholars**

- o Defense Mapping Agency (DMA) of the United States of America - Three Parameters (OLD).
- o Fajemirokun - Seven Parameters (OLD).
- o Ezeigbo - Seven Parameters (OLD).
- o Agajelu - Seven Parameters (OLD).

❖ **Objective of the Study**

To identify which of the positions computed using the old sets of transformation parameters match with the ones computed using the new transformation parameters.

❖The Nigeria Geodetic Datum Parameters

- o Ellipsoid: Clarke 1880 ($a = 6378249.145\text{m}$, $f = 1/293.465$).
- o Station Name: L40 (latitude $9^{\circ}38'08.87''\text{N}$ and longitude $6^{\circ}30'58.76''\text{E}$).
- o Orthometric height of station L40 = 281.13m.

❖Conversion between Geodetic and Cartesian Rectangular Coordinates Geodetic to Cartesian

$$\begin{aligned} X &= (N + h) \cos \varphi \cos \lambda \\ Y &= (N + h) \cos \varphi \sin \lambda \\ Z &= \left[N(1 - e^2) + h \right] \sin \varphi \end{aligned} \quad (1)$$

Where

$$N = \frac{a}{(1 - (2f - f^2) \sin^2 \varphi)^{1/2}} \quad (2)$$

$$f = \frac{a - b}{a} \quad (3)$$

Cartesian to Geodetic

$$\varphi = \tan^{-1} \left[\frac{Z}{\sqrt{X^2 + Y^2}} \left(1 - e^2 \left(\frac{N}{N+h} \right) \right)^{-1} \right] \quad (4)$$

$$\lambda = \tan^{-1} \left[\frac{Y}{X} \right] \quad (5)$$

$$h = \sqrt{X^2 + Y^2} \cdot \sec \varphi - N \quad (6)$$

Where,

e^2 = Eccentricity squared $= 2f - f^2$

N = radius of curvature as given in equation (2)

❖ Transformation between WGS84 and Minna Datum

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{\text{Minna}} = \begin{pmatrix} T_X \\ T_Y \\ T_Z \end{pmatrix} + (1 + \Delta S) \begin{pmatrix} 1 & R_Z & -R_Y \\ -R_Z & 1 & R_X \\ R_Y & -R_X & 1 \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{\text{WGS84}} \quad (7)$$

❖ Transformation Parameters Published by OSGeo

Transformation Parameters from WGS 84 to Minna Datum

$$T_x = 93.809786\text{m} \pm 0.375857310\text{m}$$

$$T_y = 89.748672\text{m} \pm 0.375857310\text{m}$$

$$T_z = -118.83766\text{m} \pm 0.375857310\text{m}$$

$$R_x = 0.000010827829 \pm 0.0000010311322$$

$$R_y = 0.0000018504213 \pm 0.0000015709539$$

$$R_z = 0.0000021194542 \pm 0.0000013005997$$

$$S = 0.99999393 \pm 0.0000010048219$$

Transformation Parameters from Minna Datum to WGS 84

$$T_x = -93.809786\text{m} \pm 0.375857310\text{m}$$

$$T_y = -89.748672\text{m} \pm 0.375857310\text{m}$$

$$T_z = 118.83766\text{m} \pm 0.375857310\text{m}$$

$$R_x = -0.000010827829 \pm 0.0000010311322$$

$$R_y = -0.0000018504213 \pm 0.0000015709539$$

$$R_z = -0.0000021194542 \pm 0.0000013005997$$

$$S = 1.00000061 \pm 0.0000010048219$$

Table 1. Transformation Parameters Used in the Petroleum Industry

PARAMETER	EXXON-MOBIL	KARIALA	CHEVRON	ELF
TX	+94.031m	+113.936m±1.21m	+92.968m	88.98m
TY	+83.317m	+88.918m±1.21m	+89.582m	83.23m
TZ	-116.708m	-113.701m±1.21m	-116.39m	-133.55m
R _x		+1.881"±0.55"		
R _y		0.204"±0.10"		
R _z		+0.222"±0.11"		
Scale(ppm)				
PARAMETER	SPDC	AGIP	NORTEC	DMA
TX	+111.916m±2.3m	+111.916m	+93.200m	92m±3m
TY	+88.852m±2.3m	+87.852m	93.310m	93m±6m
TZ	-114.499m±2.3m	-114.499m	-121.156m	-122m±5m
	-			

Table 2. Transformation Parameters Derived by Some Academic Scholars (WGS84 to Minna)

PARAMETER	AGAJELU	FAJEMIROKUN	EZEIGBO
TX	- 90.1m±1.8m	-160.4m±0.1m	-92.9m±1.6m
TY	- 107.7m±1.8 m	-67.4m±0.0m	-116.0m±2.3m
TZ	116.9m±1.8 m	144.0m±0m	116.4m±2.4m
RX	00.08"±0.8"	00.4"±3.0"	00.33"±1.1"
RY	-00.35"±1.3"	1.20"±4.6"	04.20"±1.7"
RZ	-01.73"±0.8"	01.70"±3.7"	01.70"±1.5"
Scale(ppm)	3.43±1.3	1 ± 1.4	20± 6

❑ METHODOLOGY

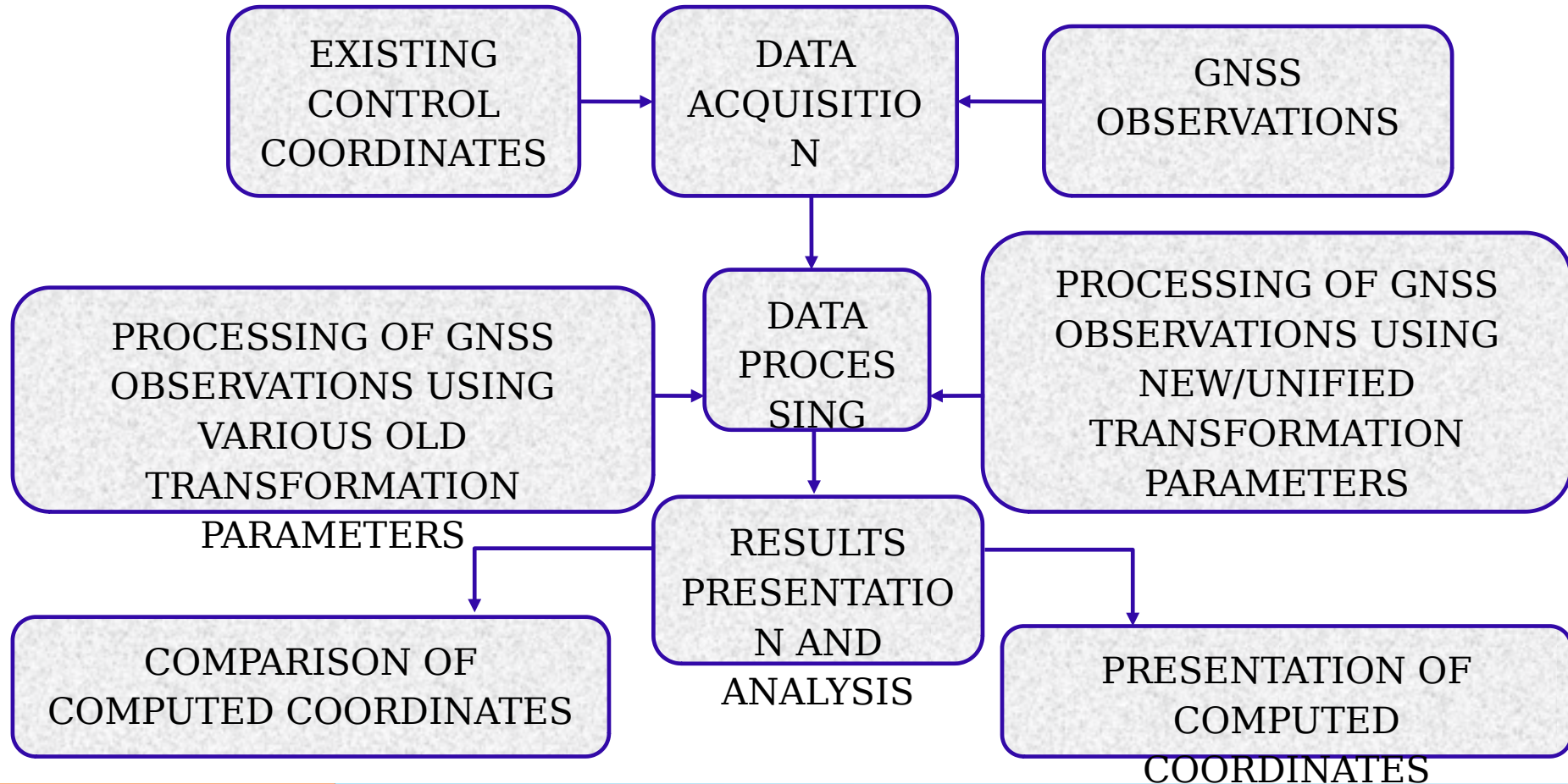


Figure 1: Adopted Methodology Flow Chart

❖ Data Acquisition

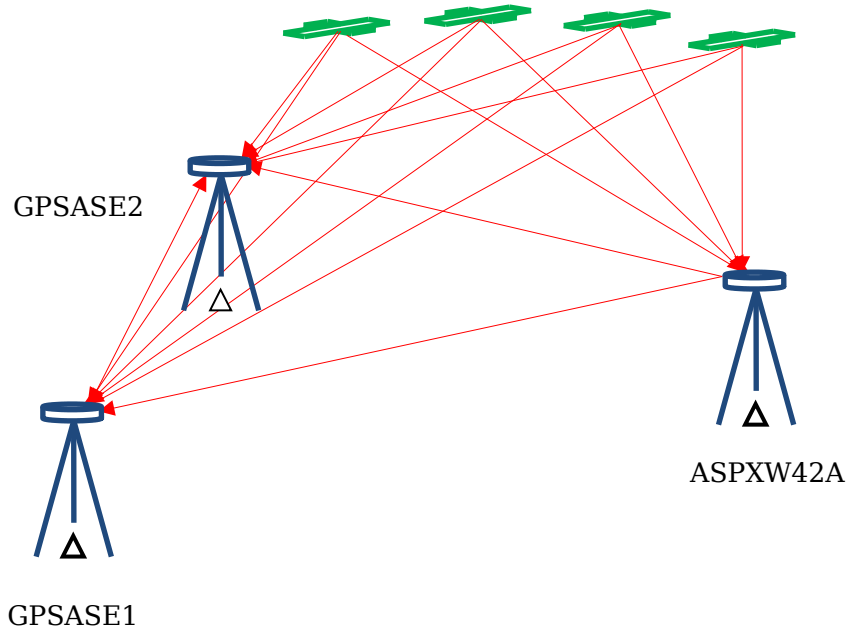


Figure 2: Loop 1 of GNSS Observation

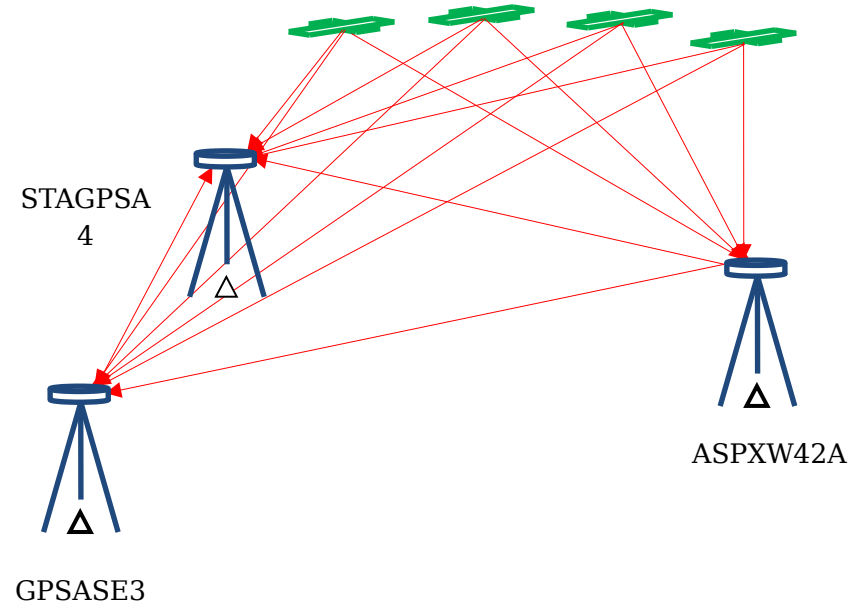


Figure 3: Loop 2 of GNSS observation

❖ Data Processing

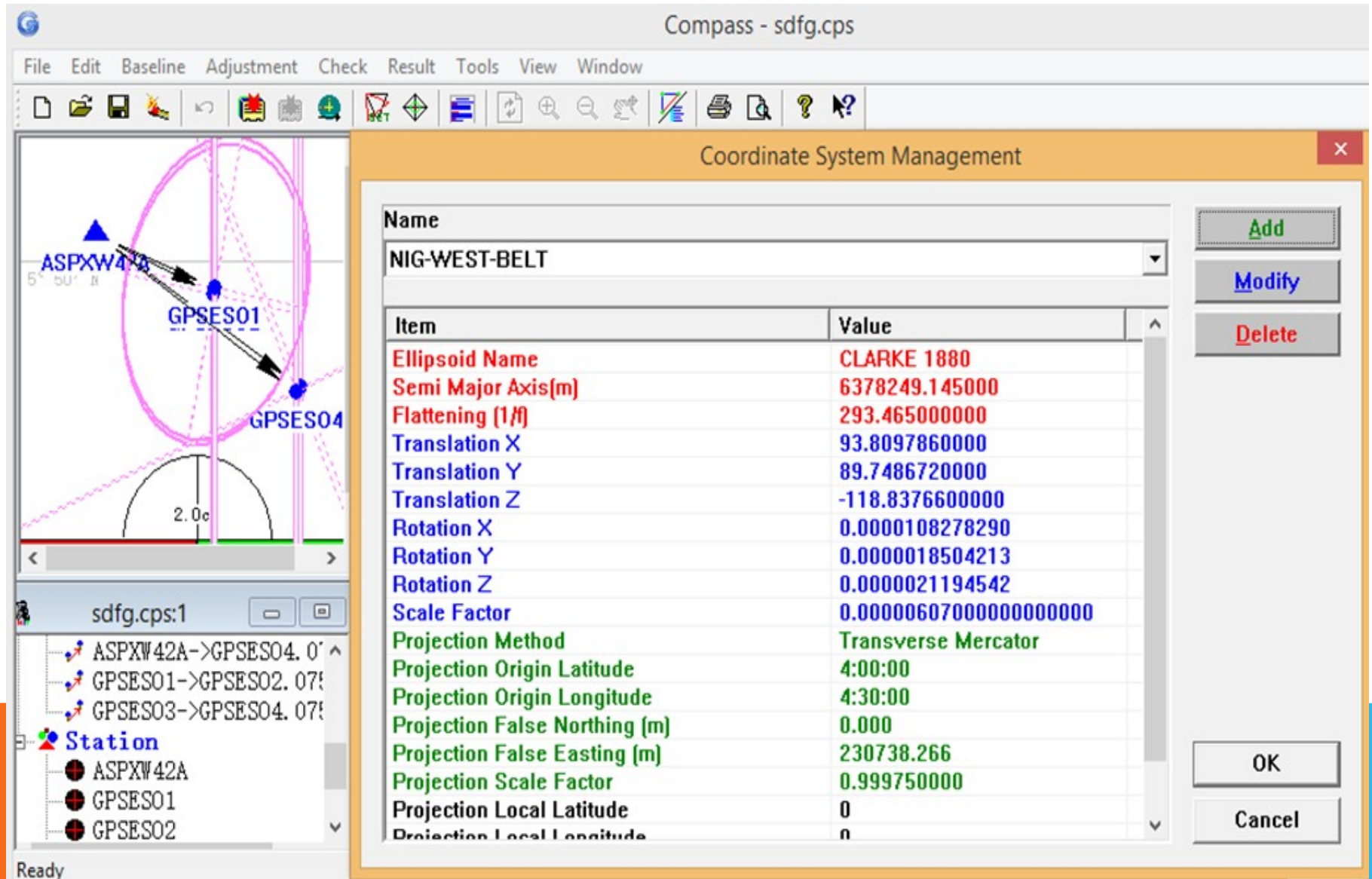


Figure 4: Processing of GNSS Observations with the New Datum Shift Parameters

❖ Results Presentation and Analysis

Table 3: Coordinates and Height Differences

OIL COMPANY/ RESEARCHER	GPSASE1			GPSASE2			GPSASE3			STAGPS4		
	DN (m)	DE (m)	Dh (m)	DN (m)	DE (m)	Dh (m)	DN (m)	DE (m)	Dh (m)	DN (m)	DE (m)	Dh (m)
SPDC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CHEVRON	-41.931	104.853	0.512	-47.306	103.023	0.534	-119.019	178.201	0.438	-122.829	175.407	0.453
EXXON-MOBIL	-41.931	104.853	0.515	-47.306	103.023	0.537	-119.019	178.202	0.443	-122.829	175.408	0.458
AGIP	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.001
DMA	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.001
NORTEC			305.778			318.305			262.100			271.386
KARIALA	-20.314	50.791	0.245	-22.918	49.905	0.255	-57.660	86.321	0.210	-59.506	84.968	0.217
ELF	-41.930	104.850	0.512	-47.304	103.020	0.533	-119.015	178.196	0.433	-122.825	175.403	0.448
FAJEMIROKUN	-664.877	1668.204	16.466	-750.101	1639.081	17.141	-1887.186	2835.156	14.263	-1947.599	2790.706	14.763
EZEIGBO	-1224.9	3082.804	317.367	-1381.9	3028.983	330.368	-3476.8	5239.284	272.036	-3588.1	5157.140	281.673

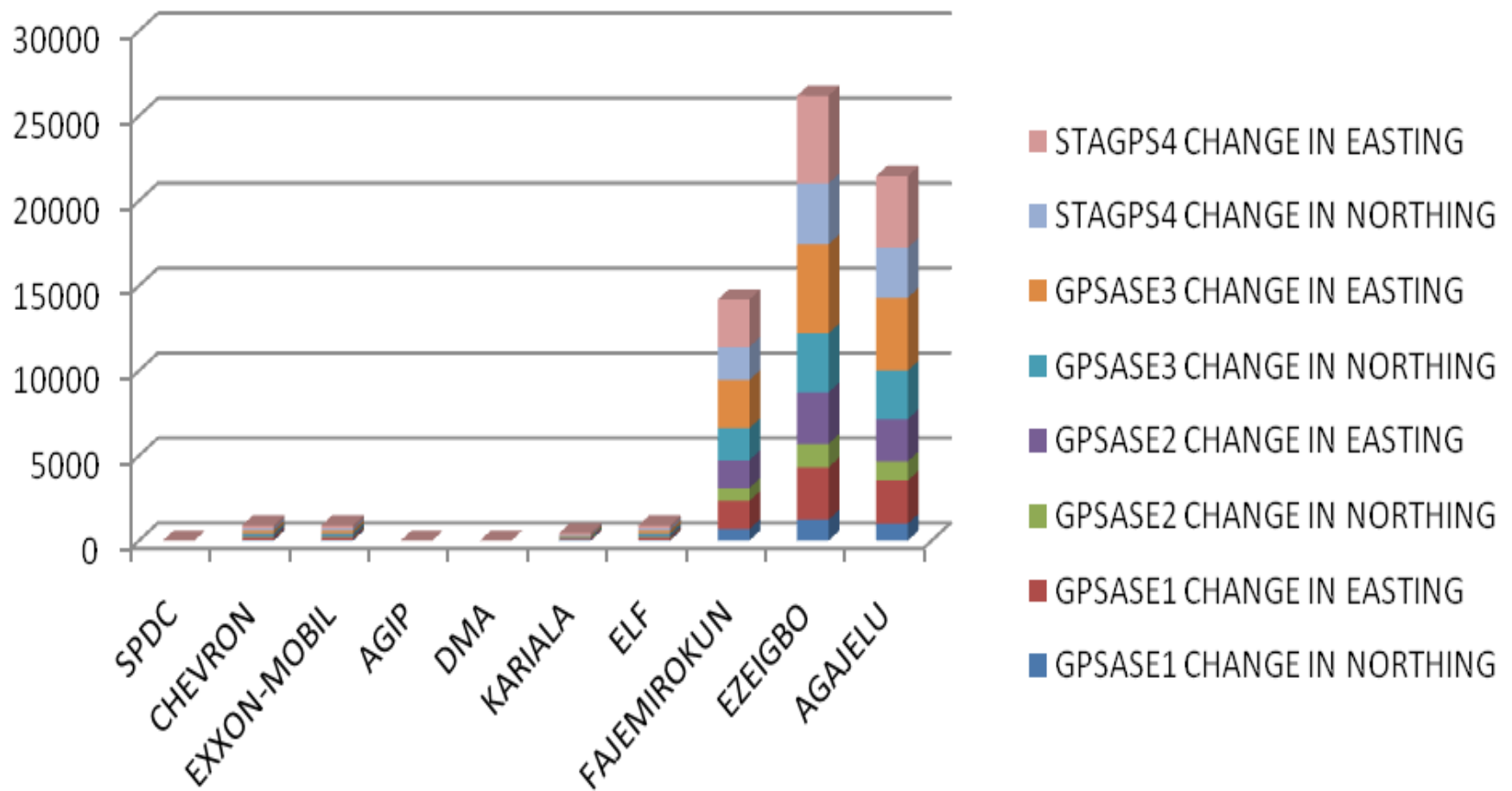


Figure 5: Plot of Change in Northings and Eastings

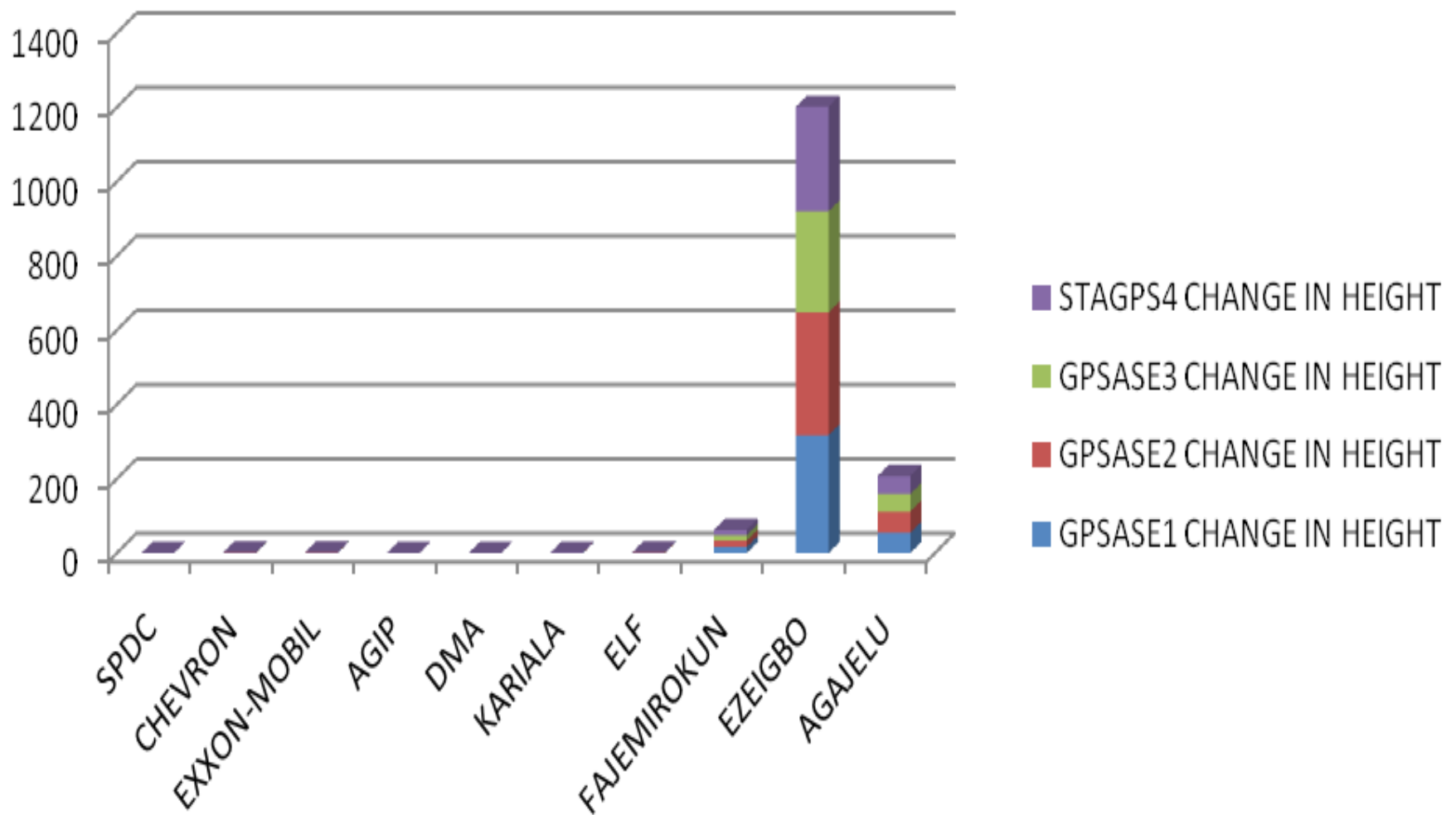


Figure 6: Plot of Ellipsoidal Heights Difference

❑ **CONCLUSION**

The findings indicate that the position calculations derived from three different old sets of transformation parameters (SPDC, AGIP, and DMA) agree with those computed using the new set of datum shift parameters.

❑ **RECOMENDATION**

It is recommended that the datum shift parameters previously determined and used by the SPDC, AGIP, and DMA are accurate and can be used for position calculation in Nigeria.

**THANK YOU FOR LISTENING
AND
GOD BLESS**